US DEPARTMENT OF ENERGY

SOLAR DECATHLON

DESIGN CHALLENGE 2022

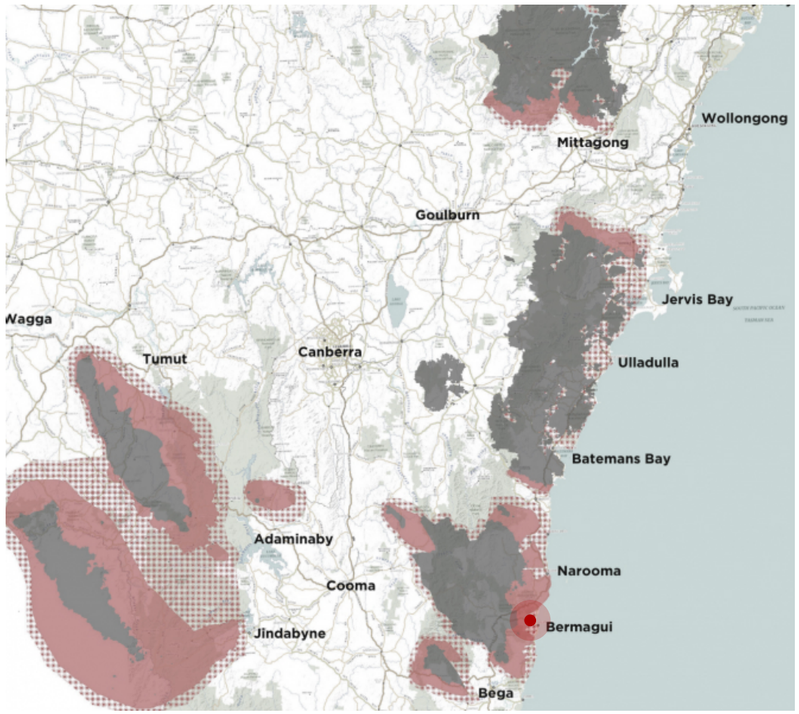
UNIVERSITY OF TECHNOLOGY, SYDNEY

DECATHAROOS

MURRAH RIVER RESIDENCE

Photograph from NSW 2019/20 Bushfires

Site Photographs

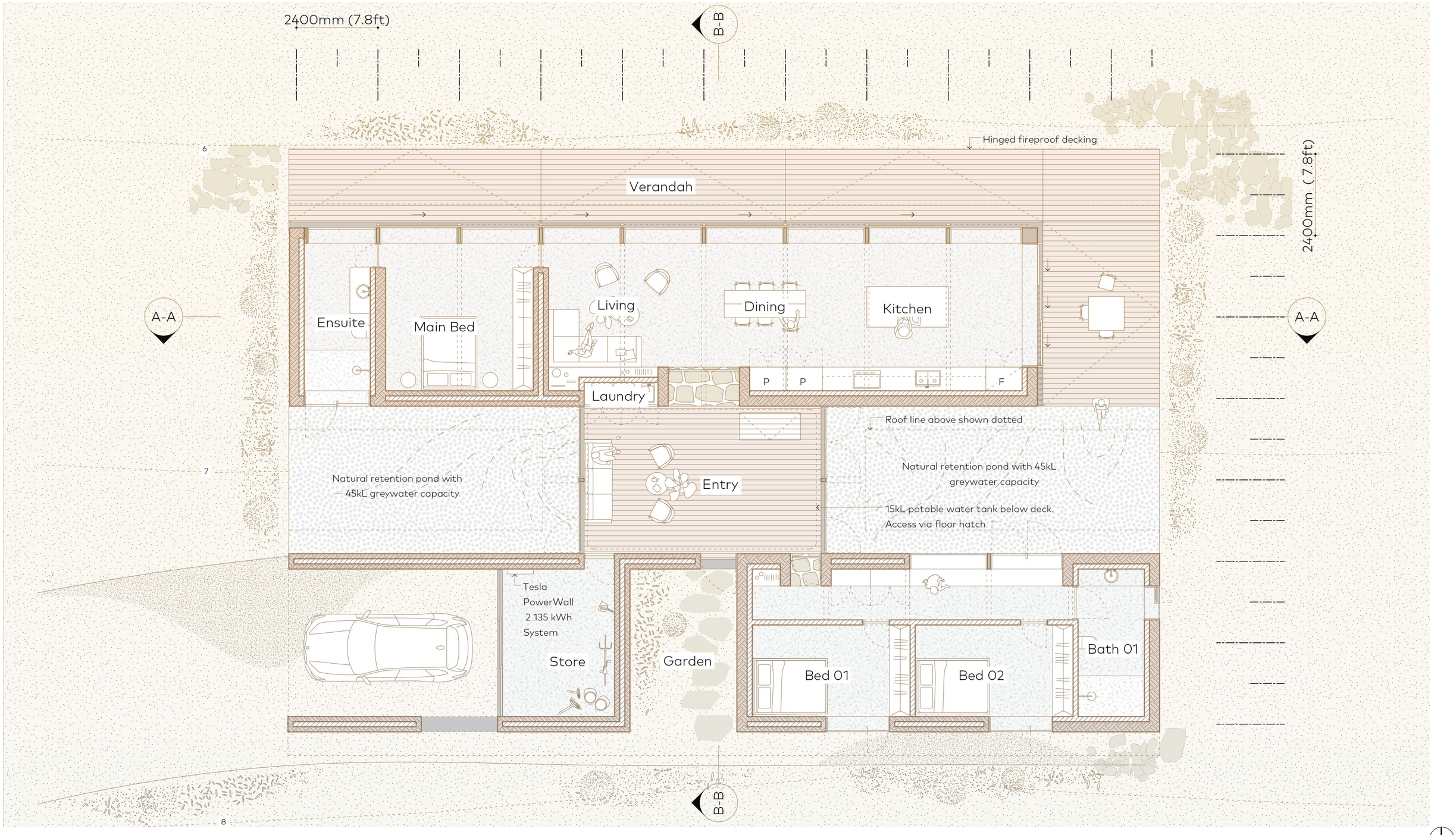


NSW Rural Fire Service 2020 Predictions NTS

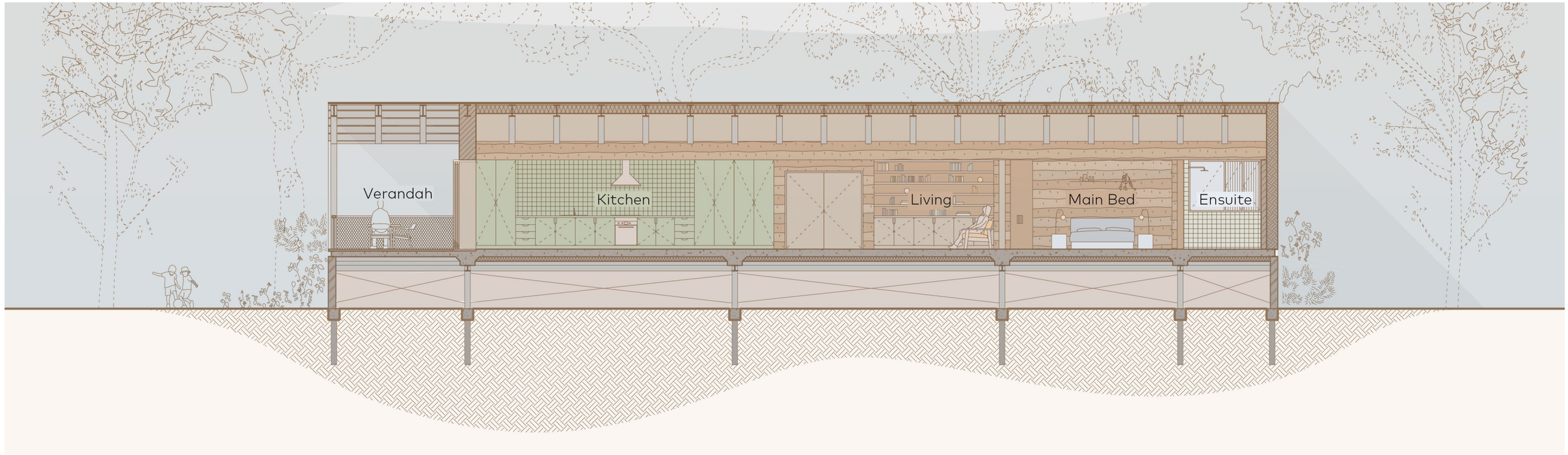
The selected site sits within a High-risk Bushfire Zone, requiring specific design strategies to compensate for this risk. The is situated on a North facing slope adjacent to the Murrah River, providing optimal solar access, prevailing on-shore winds and ideal views. The climate is Australian Zone 6, which means that it has a mild temperate climate with a low diurnal temperature range typical of coastal areas like our site. According to the Australian Bureau of Statistics, "Zone 6 has four distinct seasons, summer and winter can exceed human comfort range" with temperatures as low as the high-30s Fahrenheit in winter and as high as 100 degrees Fahrenheit in summer. The typical pattern is for cold and dry winters with hot and dry summers, while autumn and spring are very comfortable moderate temperatures.

The coastal location does tend to keep temperatures cool at night even in summer. The proximity to the coast also provides steady and constant breezes with prevailing wind blowing northeast. The local climate, combined with excellent exposure to natural sunlight and wind, makes the site ideal for passive heating and cooling and locally generated energy.

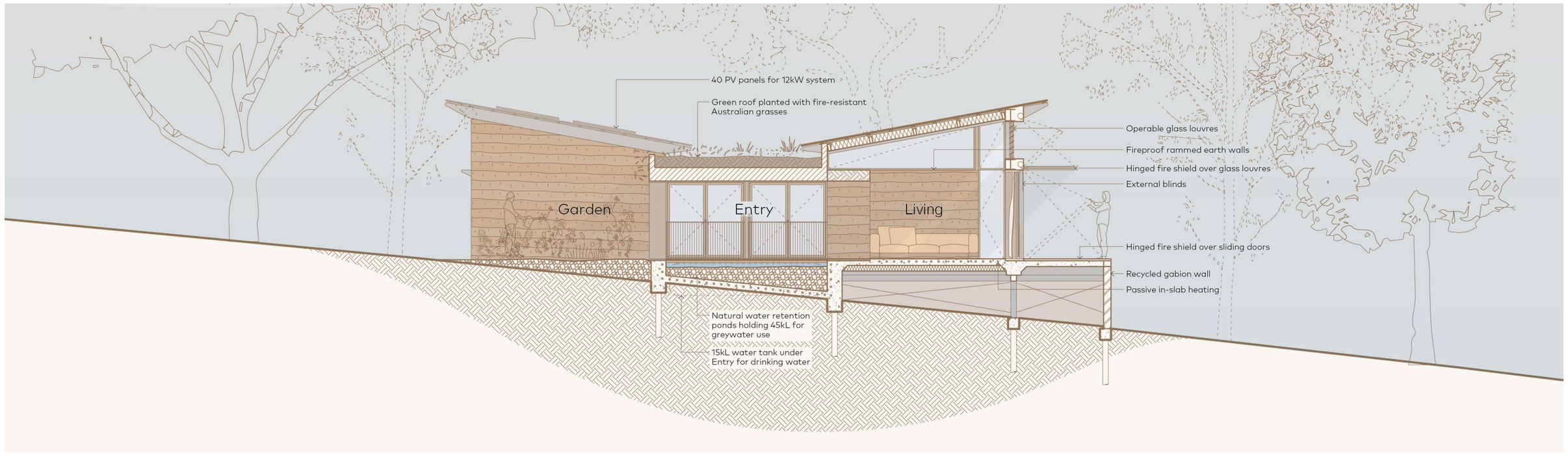
Site Plan & Constraints 1:5000



Ground Floor Plan 1:100



Section AA 1:100



Section BB 1:100

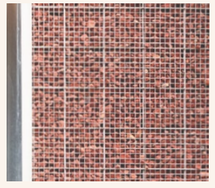
MATERIALS

1. Rammed Earth
2. Corrugated Iron
3. Gabion Wall
4. Timber (Spotted Gum) Framed Windows
5. Polished Concrete

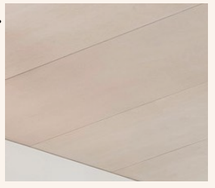
1. 

2. 

4. 

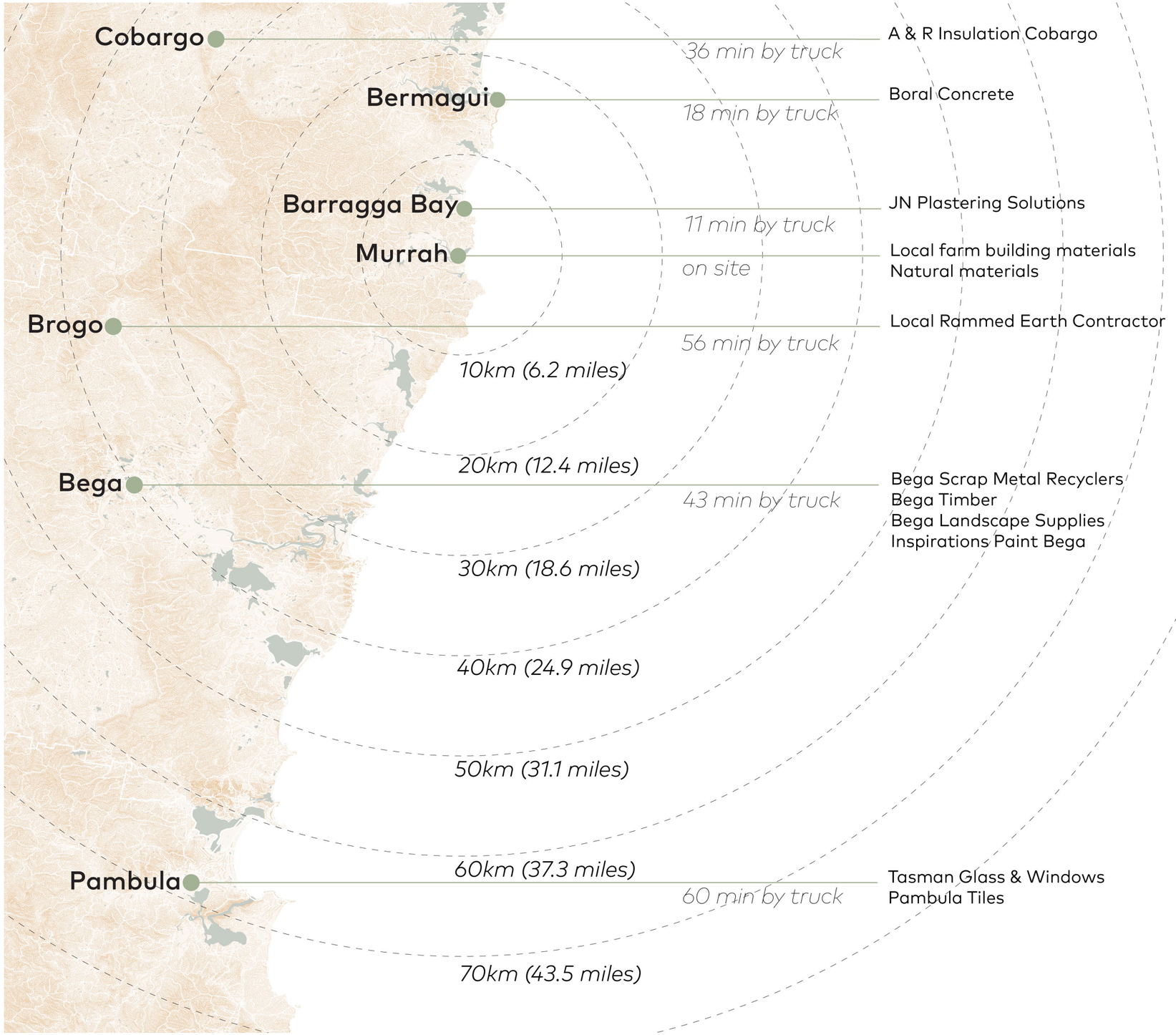
3. 

5. 

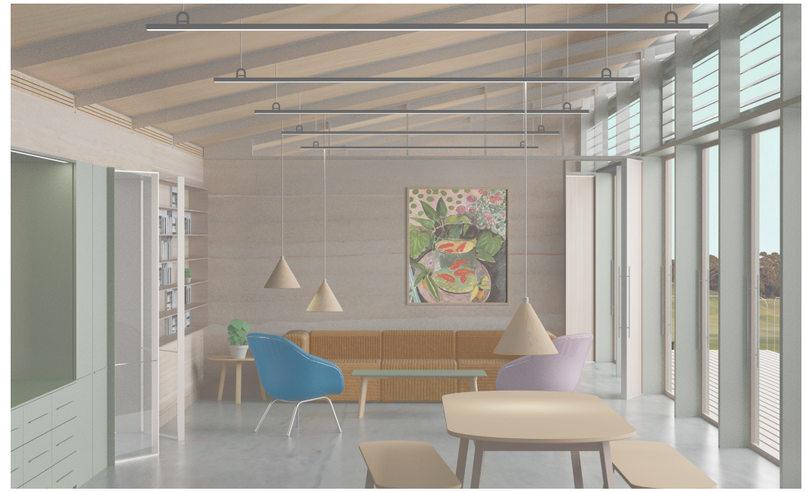
6. 

East Elevation 1:100

North Elevation 1:100



Regional Map 1:15,000



Interior Render from Dining

TYPE	INTERNAL OR EXTERNAL	TOTAL THICKNESS	TOTAL R VALUE
SLAB			
On-ground Concrete Slab & Insulation	External to Internal	225mm 8 3/4 inch	3.4
Off-ground Concrete Slab & Insulation	External to Internal	288mm 11 1/3 inch	4.6
Off-ground Timber Deck & FC Sheeting	External	120mm 4 3/4 inch	N/A
WALL			
Rammed Earth & Insulation	External to Internal	450mm 17 3/4 inch	4
Rammed Earth, Insulation & Plasterboard	External to Internal	465mm 18 1/3 inch	5
Rammed Earth, Insulation & Ceramic Tile	External to Internal	486mm 19 inch	5
Corrugated Metal, Insulation & Plasterboard	External to Internal	220mm 8 1/2 inch	4.8
Plasterboard, Insulation & Plasterboard	Internal	176mm 7 inch	5.2
Gabion Retaining	External	155mm 6 inch	N/A
ROOF			
Corrugated Metal, Insulation & Plywood	External to Internal	370mm 14 1/2 inch	6.1
Green Roof, Insulation & Fibre Cement Sheeting	External	340mm 13 1/3 inch	3

Material Schedule

INTEGRATED PERFORMANCE

1. Extended roof eaves to protect from harsh sun.

2. The butterfly roof collects rainwater and feeds to a rooftop garden or a rentention pond.

3. The rooftop garden consist of native, fire-responsive plants.

4. The planning of the house allows for passive ventilation.

5. The rentention ponds allow for passive cooling.

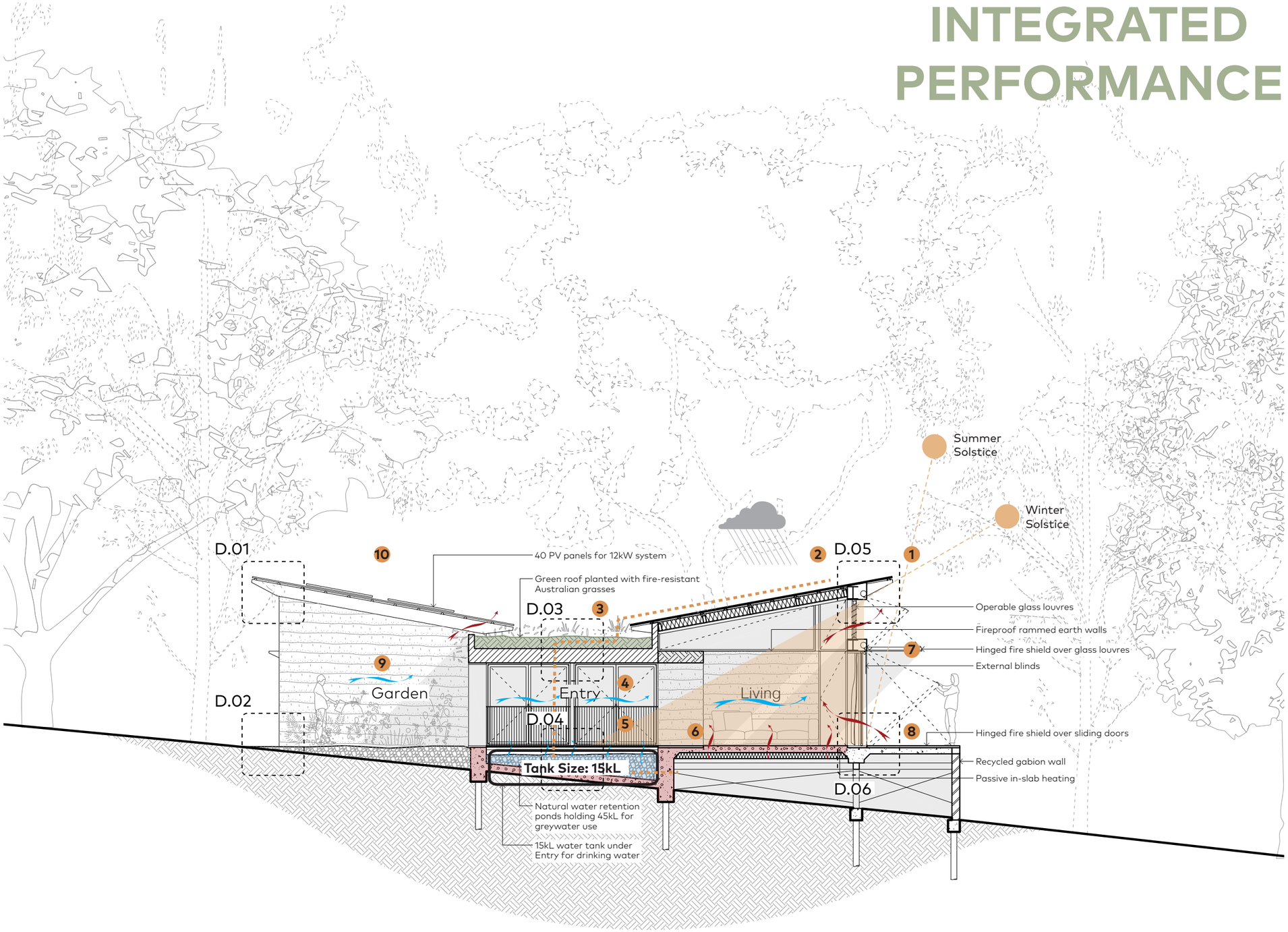
6. Concrete slabs with in-slab heating allow for passive heating.

7. The house uses simple, iconic Australian materials.

8. The verandah also acts as a fire shutter.

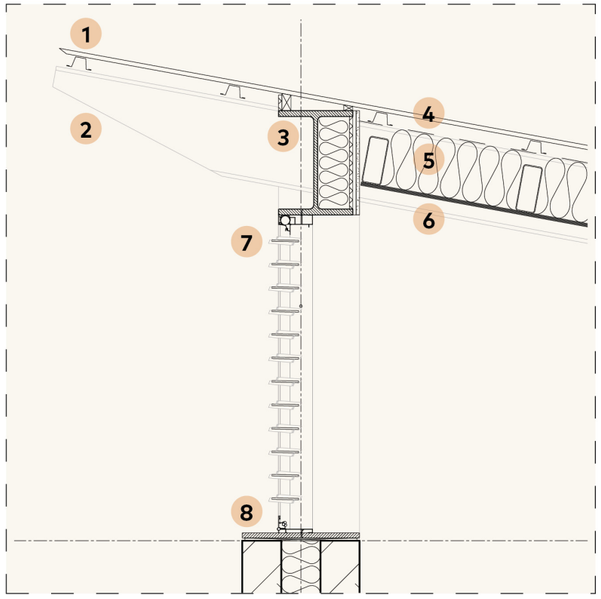
9. The Southerns walls are made from rammed earth, which is fire proof and has good insulative properties.

10. Photovoltaic panels sit on the roof to gain maximum solar intake.



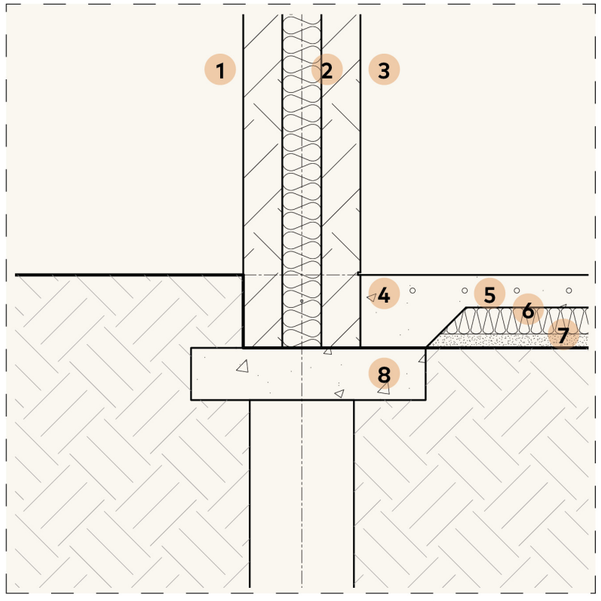
Integrated Performance Section BB

D.01



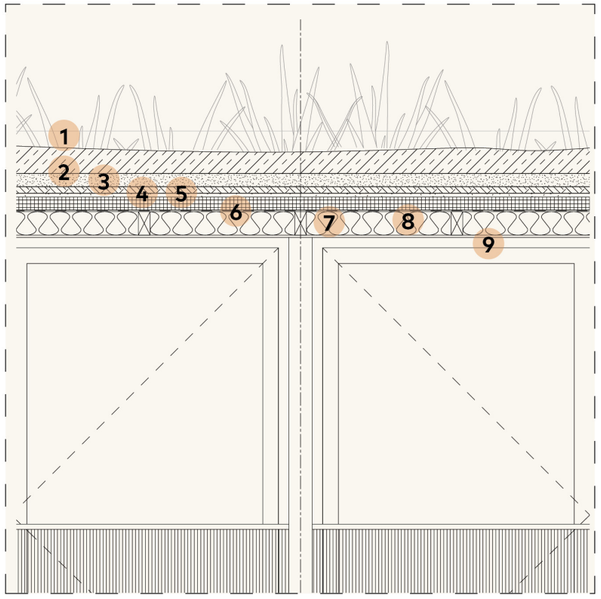
1. Colourbond Custom Orb Metal Sheet Roofing
2. 310 x 40mm (12 x 1.5 inch) Universal Beam
3. 410 x 54mm (16 x 2 inch) Universal Beam
4. Water Proof Membrane
5. 250mm (10 inch) Recycled Plastic Insulation
6. 13mm (1/2 inch) Plywood
7. Breezeway Aluminium Louvre
8. 450 x 20mm (17 3/4 x 3/4 inch) Steel Plate

D.02



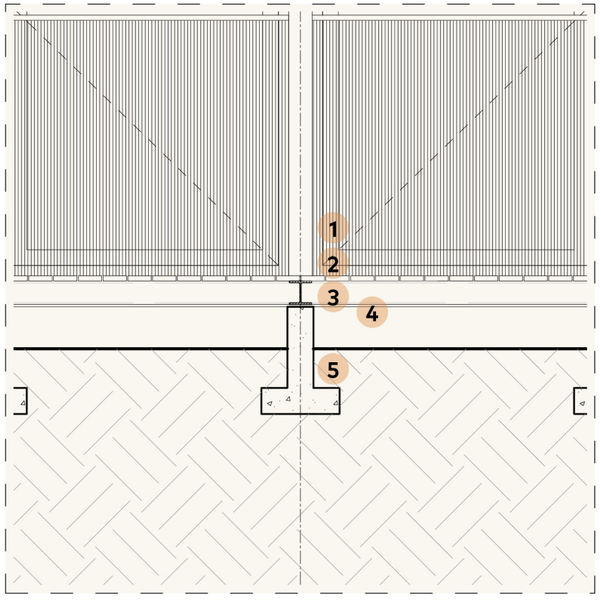
1. 150mm (6 inch) Rammed Earth
2. 150mm (6 inch) Recycled Plastic Insulation
3. 150mm (6 inch) Rammed Earth
4. 125mm (5 inch) Low Carbon Concrete Slab with In-slab Heating
5. Water Proof Membrane
6. 100mm (4 inch) Recycled Plastic Insulation
7. 50mm (2 inch) Clean Sand (fine)
8. Concrete Footing & Pile

D.03



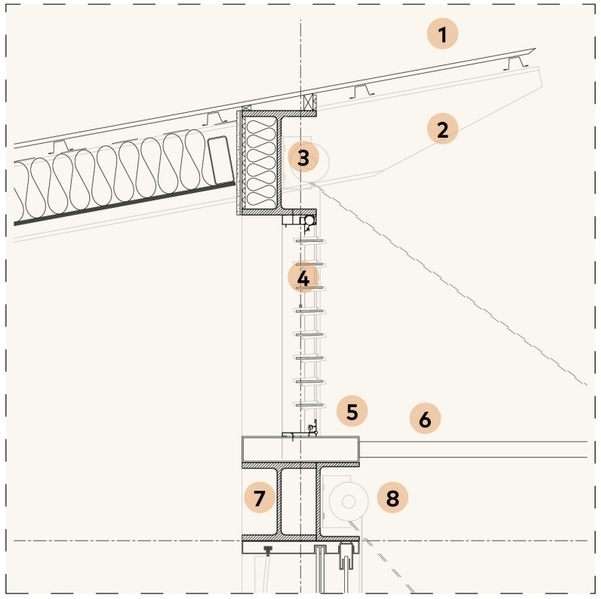
1. 100mm (4 inch) Gravel
2. 50mm (2 inch) Clean Sand
3. 25mm (1 inch) Activated Charcoal
4. 15mm (3/4 inch) Filter Material
5. 50mm (2 inch) Steel Drainage Channel
6. Water Proof Membrane
7. 90 x 45mm (3 1/2 x 1 3/4 inch) Timber Studs
8. 90mm (3 1/2 inch) Recycled Plastic Insulation
9. 13mm (1/2 inch) Fibre Cement Sheeting

D.04



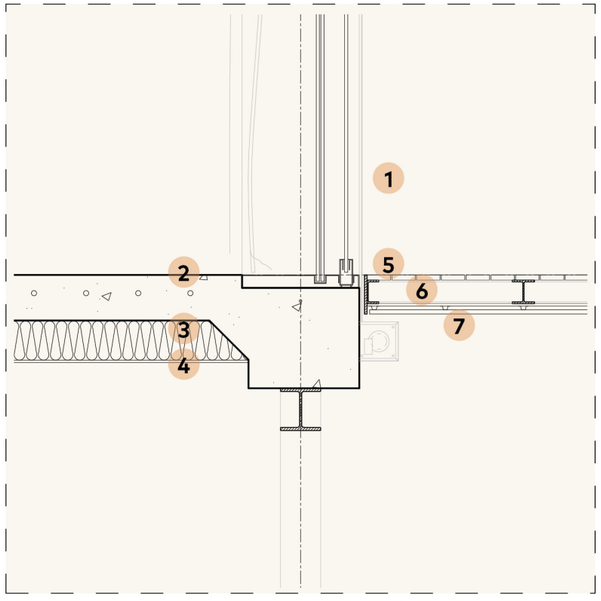
1. 90 x 90mm (3 1/2 x 3 1/2 inch) Square Hollow Section Column
2. Timber Decking
3. 90 x 75mm (3 1/2 x 3 inch) Universal Beam
4. 13mm (1/2 inch) Fibre Cement Sheeting
5. Low Carbon Concrete Footing

D.05



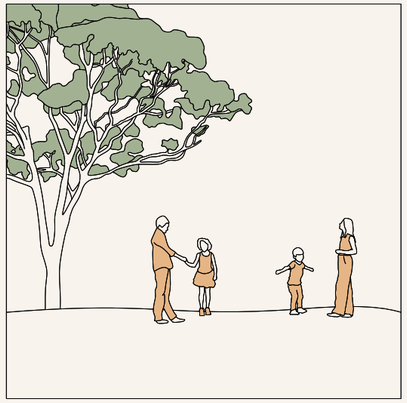
1. Colourbond Custom Orb Metal Sheet Roofing
2. 310 x 40mm (12 x 1.5 inch) Universal Beam
3. Fold-up Gear Mechanism
4. Breezeway Glass Louvre
5. 100 x 45mm (4 x 1 3/4 inch) Steel Profile
6. Hinged Fire Shield
7. 310 x 40mm (12 x 1.5 inch) Universal Beam & 300mm (12 inch) Parallel Flange Channel
8. Fold-up Gear Mechanism

D.06

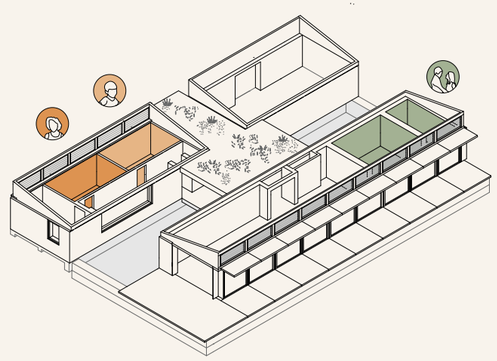


1. Triple Glazed Fixed Window & Sliding Door
2. 125mm (5 inch) Low Carbon Concrete Slab with In-slab Heating
3. 150mm (6 inch) Recycled Plastic Insulation
4. 13mm (1/2 inch) Fibre Cement Sheeting
5. Timber Decking
6. 90 x 75mm (3 1/2 x 3 inch) Universal Beam
7. 13mm (1/2 inch) Fibre Cement Sheeting

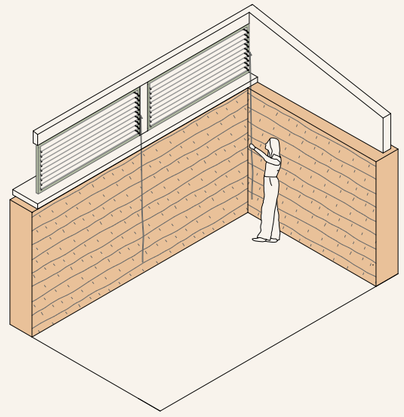
Construction Details 1:20



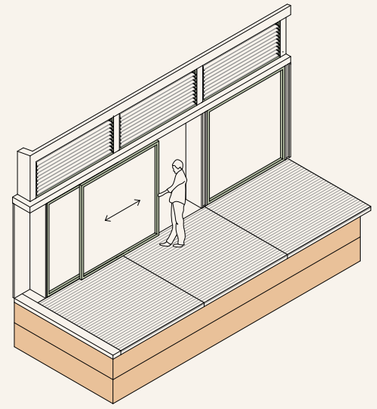
TARGET MARKET



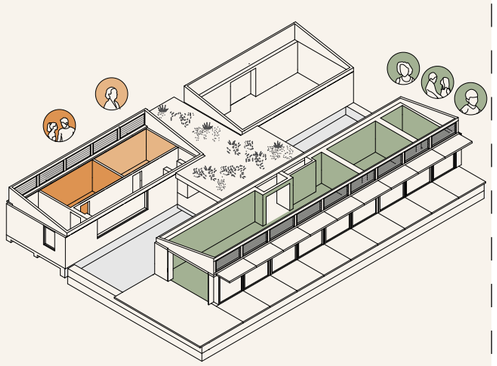
FLEXIBLE LIVING



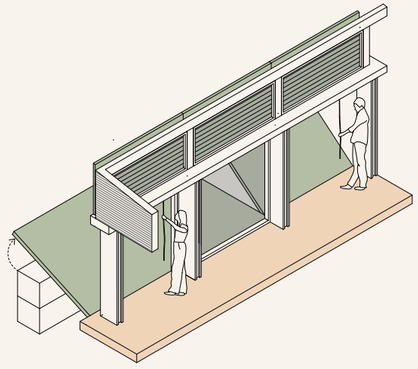
MANUAL VENTILLATION



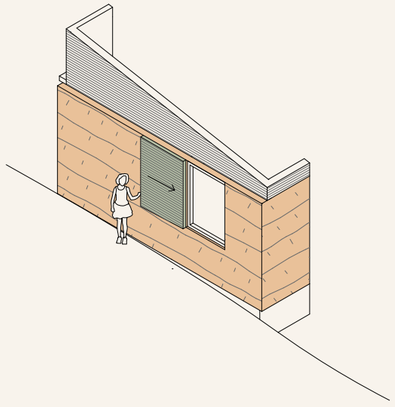
INDOOR/OUTDOOR LIVING



COMMUNITY BUSHFIRE RESPONSE



FOLDING BUSHFIRE SHUTTERS



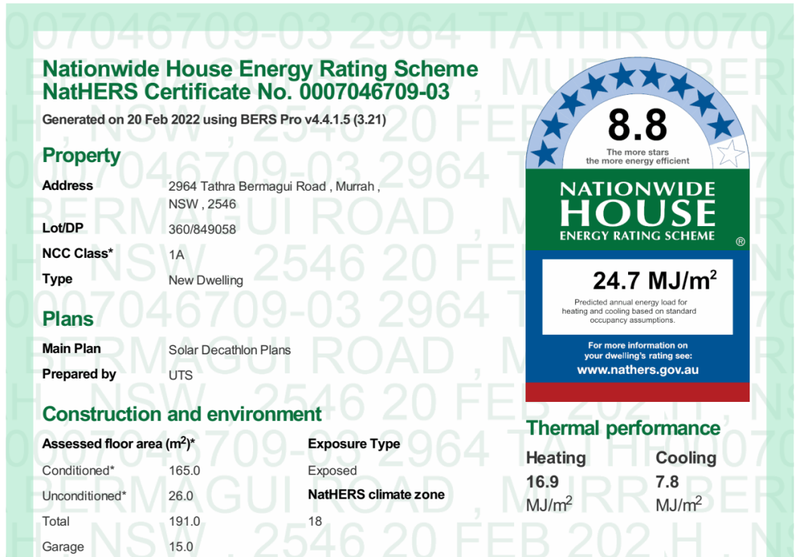
SLIDING BUSHFIRE SHUTTERS

In addition, the house is designed to meet bushfire threats common in the area. It meets the strict BAL FZ (Flame Zone) Requirements which designs for direct exposure to flames as well as heat flux and ember attack.

We also envision the house to be part of a wider community response to bushfire threats; it will be equipped with sensors to provide information for fire warning and monitoring.

OCCUPANT EXPERIENCE

ENERGY PERFORMANCE



Nationwide House Energy Rating Scheme
NatHERS Certificate No. 0007046709-03

Generated on 20 Feb 2022 using BERS Pro v4.4.1.5 (3.21)

Property

Address	2964 Tathra Bermagui Road , Murrah , NSW , 2546
Lot/DP	360/849058
NCC Class*	1A
Type	New Dwelling

Plans

Main Plan	Solar Decathlon Plans
Prepared by	UTS

Construction and environment

Assessed floor area (m^2)*		**Exposure Type**
Conditioned*	165.0	Exposed
Unconditioned*	26.0	**NatHERS climate zone**
Total	191.0	18
Garage	15.0	

8.8
The more stars the more energy efficient
NATIONWIDE HOUSE ENERGY RATING SCHEME
24.7 MJ/m²
Predicted annual energy load for heating and cooling based on standard occupancy assumptions.
For more information on your dwelling's rating see:
www.nathers.gov.au

Thermal performance

Heating	**Cooling**
16.9 MJ/m^2	**7.8** MJ/m^2

NatHERS Certificate & Specification Summary

External Walls
Rammed Earth, lined, Medium Colour, R3.7 Bulk insulation

Internal Walls
Around bedroom 2 & bedroom 3: Plasterboard, R3.7 Bulk insulation
Other: Rammed Earth, R3.7 Bulk insulation

Floor
Kitchen/Living, Master Bed & Ensuite: Suspended Concrete Slab, R3.7 Bulk insulation
Other: Concrete Slab on Ground, R2.5 Bulk insulation

Ceiling
Entry: Plasterboard, R2.2 Bulk insulation
Other: Plasterboard, R6.0 Bulk insulation

Roof
Entry: Waterproofing Membrane, No insulation
Other: Corrugated Iron, Light Colour, Foil, Reflective side down, Anti Glare up

Glazing
Sliding Doors: U-value 1.08 and SHGC 0.27
Casement Windows: U-value 1.39 and SHGC 0.39

	HEATING LOAD MJ/m^2	COOL LOAD MJ/m^2	STAR RATING
On-ground Concrete Slab	73.5	31.5	N/A
Off-ground Concrete Slab	78.4	34.6	N/A
Approximate for our Dwelling	75	32.5	N/A

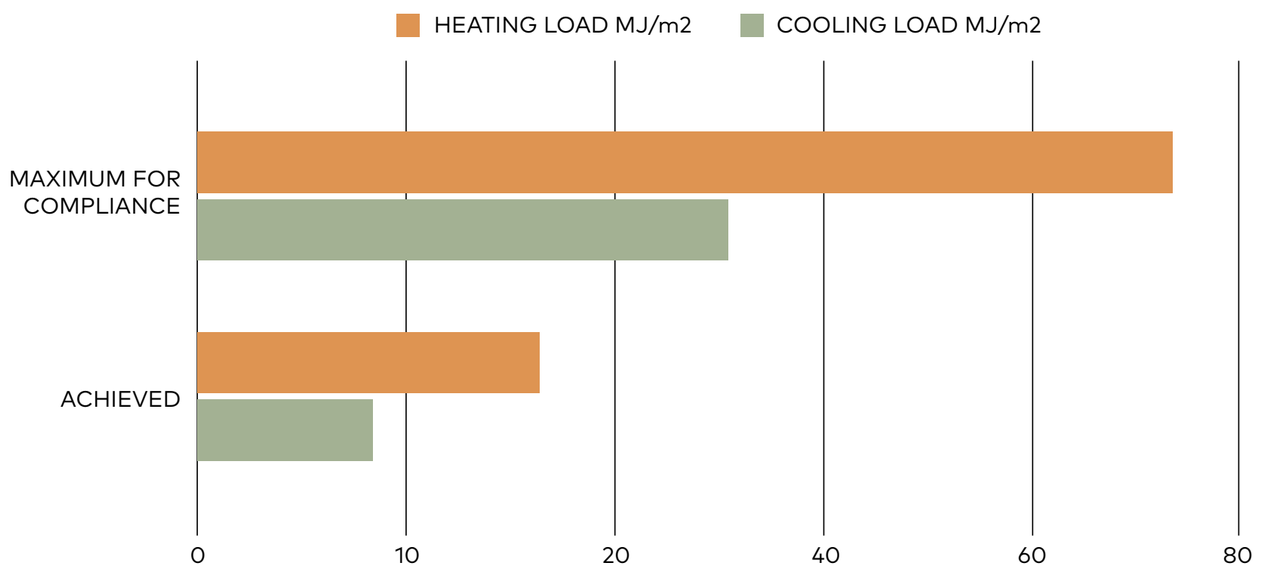
Compliance Requirements for New Single Dwelling in NSW

	HEATING LOAD MJ/m^2	COOL LOAD MJ/m^2	STAR RATING
For our Dwelling	16.9	7.8	8.8

Loads Achieved for New Single Dwelling in NSW

Energy performance was assessed using the Nationwide House Energy Rating Scheme (NatHERS). This allowed for the assessment of thermal comfort of the home without any other energy systems. Establishing the compliance energy targets that need to be met by each new single residential dwelling was done using the 2020 BASIX Thermal Comfort Protocol as the NCC 2019 Amendment 1 describes as necessary for all NSW, Australia dwellings. The assessment was carried out in Bers Pro v4.4.1.5 which is one of the approved NatHERS softwares and the modelling was done in accordance with the NatHERS assessor handbook and NatHERS technical notes.

Strategies used to reduce the overall heating and cooling loads were using high amounts of insulation in the walls, ceiling, roof as well as the floor, both suspended and slab on ground concrete. Also, the use of low u-values and varying SHGC values that is consistent with triple glazing provided great overall thermal performance for the building. Eave lines and shading devices were also considered based on the need for daylight to come through while still providing shading where needed.

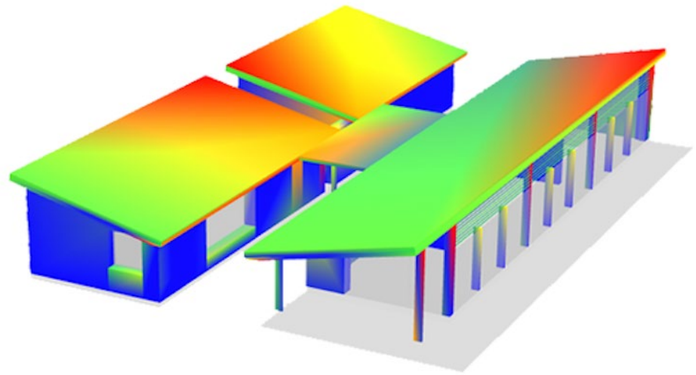


Compliance Heating & Cooling Loads vs Loads Achieved

ENGINEERING

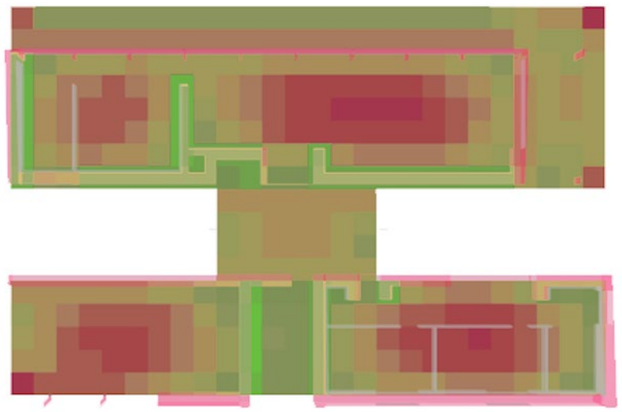
◀ LOW SPATIAL DAYLIGHT AUTONOMY HIGH ▶

10% 30% 50% 70% 90%



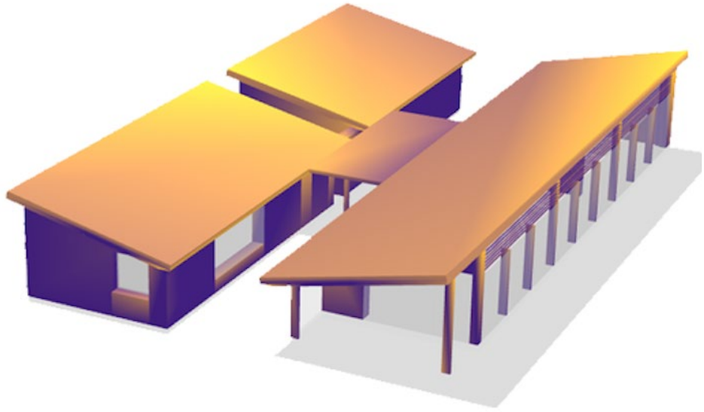
◀ LOW SUNLIGHT HOURS HIGH ▶

0% 20% 40% 60% 80% 100%



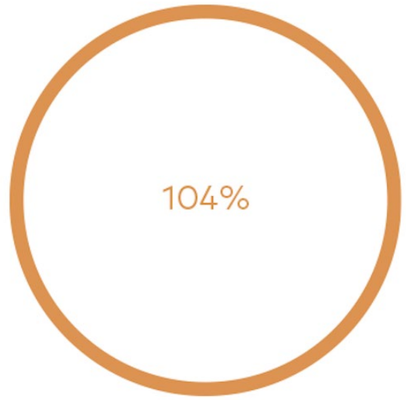
◀ LOW COVID OCCUPANCY HIGH ▶

0% 20% 40% 60% 80% 100%



◀ LOW RADIATION HIGH ▶

10% 30% 50% 70% 90%



2030 BASELINE EMISSIONS	91 TONNE C02e/yr
	-4 TONNE C02e/yr

To contextualise the building in its proposed environment, we uploaded a model into Cove Tool and benchmarked the design against the ASHRAE Residential 2018 Energy Code. We assumed that the house would be un-occupied between the hours of 8am and 4pm, and half occupied between 4 and 6pm to represent a typical school and work schedule for a 4-person family. Moreover, analysis was completed at a height of 1.5m above ground-level to achieve results relevant to the experience of occupants. As a unit, it performs exceptionally well in both its purpose to be a space for comfortable environmental living and a benchmark for sustainable single family home design.

The house boasts a People Outdoor Area Rate of 12.5L/S/P, which exceeds the minimum requirements of the Passivhaus and Green Star Standards by 50%. Additionally, it being fitted with daylight and occupancy sensors understands when power usage can be reduced or stopped completely to minimise yearly CO2 emissions and electricity costs.

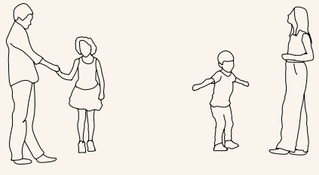
According to figures provided by Ausgrid, the sum of wattage required for appliance use in our house during unoccupied hours is 310 kwh/yr (fridge) and 730kwh/yr (Heat Pump hot water system). When occupied, assuming half the house is lighted at any one time during ALL occupied hours, we end up with an appliance use figure of 5.54W/m2 or 0.515 W/ft2.

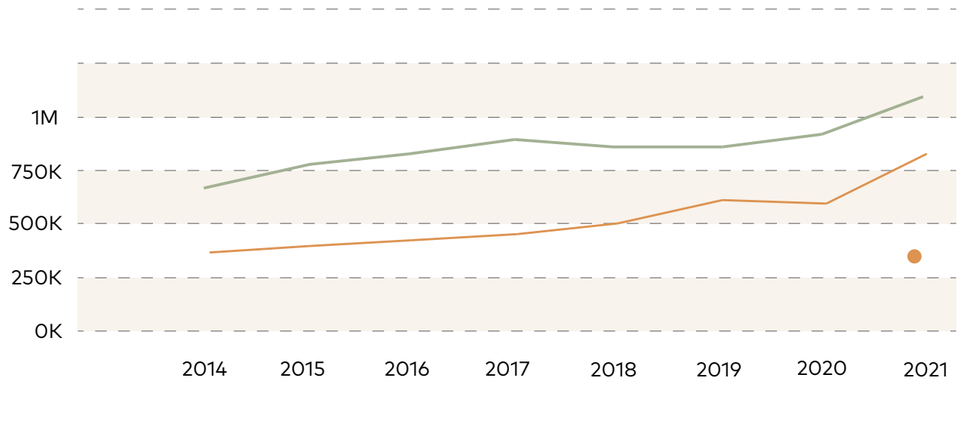
MARKET ANALYSIS

New South Wales has one of the most expensive housing markets in the world; according to the The Urban Developer, the city of Sydney's median house price is $1.3 million AUD, while the median house price for the region on the South Coast where our site is located is between $820,000 AUD and $830,500 AUD for a 3-bedroom house. Propelled by the pandemic and the population flight from the city, the South Coast has become a new life-style hot spot. Its idyllic locations in untouched native bush, near the coast, coupled with temperate climate, have made it extremely popular in the last two years.

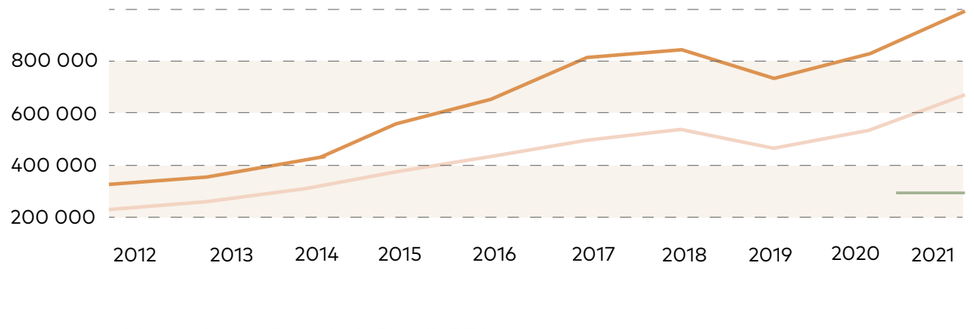
The cost of a block of land on the South Coast varies but it is possible to purchase residential blocks for $200,000 AUD in the area where our site is located. Combined with our project construction costs of $150,000, this would make the total cost $350,000 plus any site work, which is within reach of the average resident. Weekly repayments would be about $255 - $280 AUD as opposed to average $711 AUD weekly mortgage repayments on an existing house. This means our design makes housing more easily attainable for the average Australian family.

Our proposal is even more attractive when the current state of the for-purchase market in our area is considered: there are very few existing houses for sale. Bermagui has only 4 houses for sale that are a comparable size at the moment and Tathra has 3. There is more vacant land for sale, especially when locations outside the towns are taken into account.



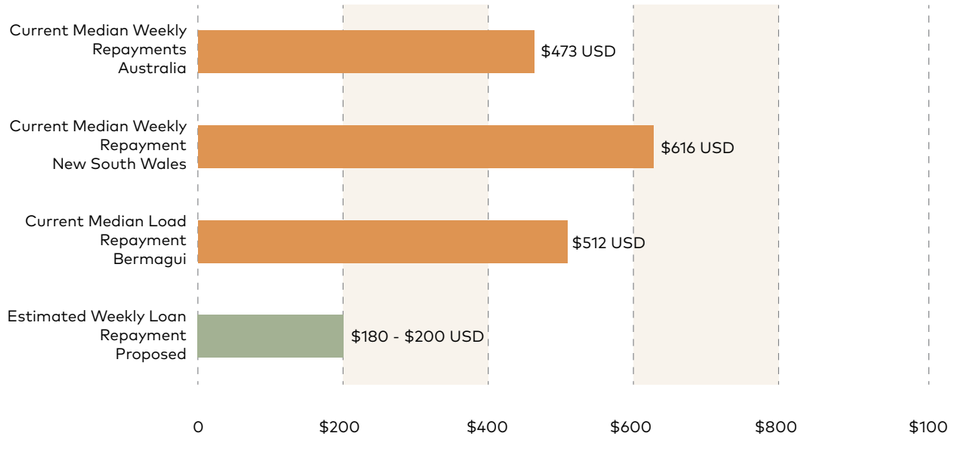


Average House Price AUD

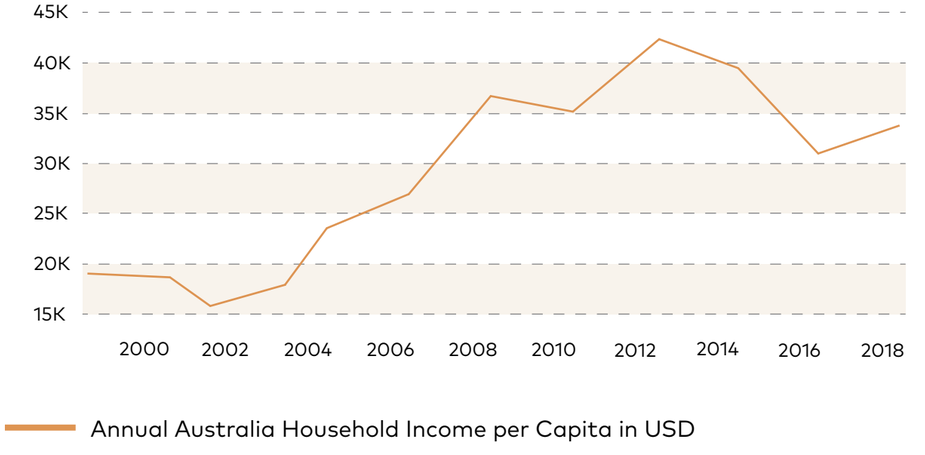


Average House Price USD

Created using data from www.abs.gov.au



Average Weekly Loan Repayment



Average Household Income

West Render from Natural Retention Pond